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Foreword

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The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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x the first digit:

1 presented to TSG for information;

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3 Indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the specification.

1. Scope

The scope of this description is the specification of the MAC protocol.

The following lists the contents for the specification of the MAC protocol:
1. list of procedures
2. logical flow diagrams for normal procedures
3. logical description of message
4. principles for error handling
5. some exceptional procedures which are felt criteria
6. It should, as far as possible, have the same format and outline as the final specification
7. exact message format
8. all scenarios

Note: The list has to be reviewed.

2. References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an TS shall also be taken to refer to later versions published as an EN with the same number.

[1] 3GPP Homepage: www.3GPP.org
[2] TS25.301, Radio Interface Protocol Architecture
[3] TS25.302, Layer 1; General requirements
[4] TS25.303, UE States and Procedures in Connected Mode
[5] TS25.304, Description of procedures in idle Mode
[6] TS25.322, Description of RLC protocol
[7] TS25.331, Description of RRC protocol
[8] TS25.391, Description of principles for error handling and message description
[9] ETSI UMTS 25.XX: "Vocabulary for the UTRAN"

3. Definitions, abbreviations and symbols

3.1 Definitions

See [9] for a definition of fundamental concepts and vocabulary.

3.2 Abbreviations

ARQ	Automatic Repeat Request
ASC	Access Service Class
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
C-	Control-
CC	Call Control
CCCH	Common Control Channel
CCTrCH	Coded Composite Transport Channel
CPCH	Common Packet Channel (UL)
CN	Core Network
CRC	Cyclic Redundancy Check
DC	Dedicated Control (SAP)
DCA	Dynamic Channel Allocation
DCCH	Dedicated Control Channel
DCH	Dedicated Channel
DL	Downlink
DRNC	Drift Radio Network Controller
DSCH	Downlink Shared Channel
DTCH	Dedicated Traffic Channel
FACH	Forward Link Access Channel
FAUSCH	Fast Uplink Signalling Channel
FCS	Frame Check Sequence
FDD	Frequency Division Duplex
GC	General Control (SAP)
HO	Handover
ITU	International Telecommunication Union
kbps	kilo-bits per second
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
LAC	Link Access Control
LAI	Location Area Identity
MAC	Medium Access Control
MM	Mobility Management
Nt	Notification (SAP)
OCCCH	ODMA Common Control Channel
ODCCH	ODMA Dedicated Control Channel
ODCH	ODMA Dedicated Channel
ODMA	Opportunity Driven Multiple Access
ORACH	ODMA Random Access Channel
ODTCH	ODMA Dedicated Traffic Channel
PCCH	Paging Control Channel
PCH	Paging Channel
PDU	Protocol Data Unit
PHY	Physical layer
PhyCH	Physical Channels
RACH	Random Access Channel
RLC	Radio Link Control

RNC	Radio Network Controller
RNS	Radio Network Subsystem
RNTI	Radio Network Temporary Identity
RRC	Radio Resource Control
SAP	Service Access Point
SCCH	Synchronization Control Channel
SCH	Synchronization Channel
SDU	Service Data Unit
SRNC	Serving Radio Network Controller
SRNS	Serving Radio Network Subsystem
TDD	Time Division Duplex
TFCI	Transport Format Combination Indicator
TFI	Transport Format Indicator
TMSI	Temporary Mobile Subscriber Identity
TPC	Transmit Power Control
U-	User-
UE	User Equipment
UE_R	User Equipment with ODMA relay operation enabled
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
USCH	Uplink Shared Channel
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

3.3 Symbols

4. General

4.1 Objective

4.2 Overview on MAC architecture

The following provides an overview of a common MAC architecture that encompasses both UMTS-FDD and UMTS-TDD. There are differences of detail between the two systems but their architectures are sufficiently similar for a common overview to be adopted. Followed by section 4.2.1 MAC entities, where the different MAC entities are summarised, the sections 4.2.2-4 contain a more detailed description of the MAC architecture.

Note: The contents have to be reviewed, changes depend on further contributions

4.2.1 MAC Entities

The diagrams that describe the MAC architecture are constructed from MAC entities. The entities are assigned the following names. The functions completed by the entities are different in the UE from those completed in the UTRAN:

- MAC-b, which identifies the MAC entity that handles the broadcast channel (BCH). There is one MAC-b entity in each UE and one MAC-b in the UTRAN for each cell.

  Note: The separation in two different BCCH is ffs, the control SAP may be split accordingly
- MAC-p, which identifies the MAC entity that handles the paging channel (PCH). There is one MAC-p entity in each UE and one MAC-p in the UTRAN for each cell.
- MAC-c, which identifies the MAC entity that handles the forward access channel (FACH), the random access channel (RACH) and the Common Packet Channel (UL CPCH) for FDD. There is one MAC-c entity in each UE and one in the UTRAN for each cell.
- MAC-d, denotes the MAC entity that is responsible for handling of dedicated logical channels and dedicated transport channels (DCH) allocated to a UE. There is one MAC-d entity in the UE and one MAC-d entity in the UTRAN for each UE. Note: *When a UE is allocated resources for exclusive use by the bearers that it supports the MAC-d entities dynamically share the resources between the bearers and are responsible for selecting the TFI/ TFCI that is to be used in each transmission time interval.*
- MAC-sh, denotes the MAC entity that handles downlink shared channels (DSCH) for both FDD and TDD and uplink shared channels (USCH) for TDD . There is one MAC-sh entity in each UE that is using a DSCH and a USCH for TDD operation and one MAC-sh entity in the UTRAN for each cell that contains a DSCH and a USCH for TDD operation.
- MAC-sy, identifies the MAC entity used in TDD operation to handle the information received on the synchronisation channel SCH

According to the RRC functions the RRC is generally in control of the internal configuration of the MAC.

4.2.2 MAC-b , MAC-p and MAC-sy

The following diagram illustrates the connectivity of the MAC-b , MAC-p and MAC-sy entities in a UE and in each cell of the UTRAN:

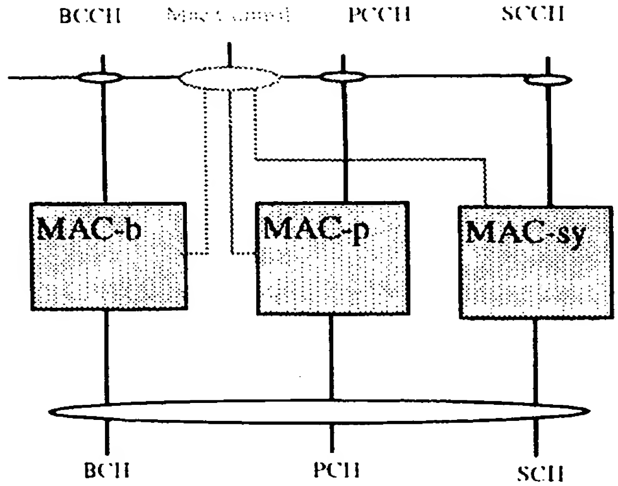


Figure 4.2.2.1 UE side and UTRAN side architecture (BCCH ,PCCH and SCCH)

MAC-b, MAC-p and MAC-sy represents SCH, BCH and PCH control entities, which are cell-specific MAC entities in the UTRAN. In the UE side there is one SCH, BCH and PCH control entity per UE. The SCH control entity handles synchronisation channels for the TDD mode. The details of this entity are left for further study. The MAC Control SAP is used to transfer Control information to each MAC entity.

4.2.3 Traffic Related Architecture - UE Side

Figure 4.2.3.1 illustrates the connectivity of MAC entities. The figure shows a MAC-d servicing the needs of several DTCH mapping them to a number of DCH. A MAC-sh controls access to a common transport channel. It is noted that because the MAC-sh provides additional capacity then it communicates only with the MAC-d rather than the DTCH directly. The MAC-c, which interfaces with the FACH and RACH common signalling channels, is connected with the MAC-d for transfer of data and RNTI. The MAC Control SAP is used to transfer Control information to each MAC entity. In the TDD implementation the MAC-sh transfers data from the DSCH to the MAC-d and from the MAC-d to the USCH under control of the FACH. In the FDD implementation, the MAC-c may transfer data from the MAC-d to the CPCH.

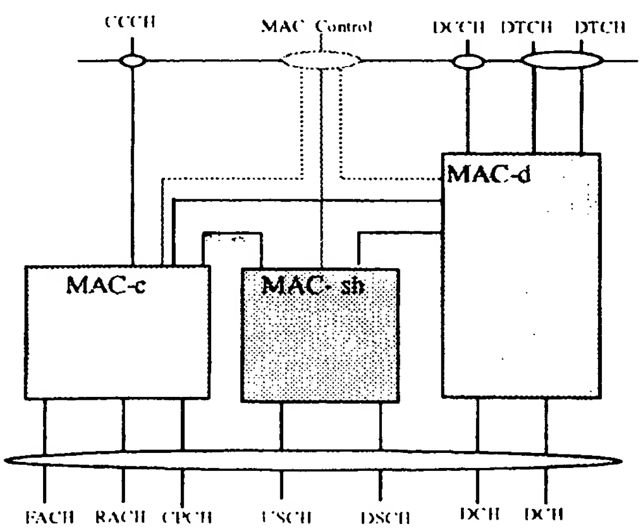


Figure 4.2.3.1 UE side MAC architecture

Figure 4.2.3.2 shows the UE side MAC-c entity. The following functionality is covered:

- The C/D MUX box represents the insertion and detection of the field in the MAC header, indicating whether a common or dedicated logical channel is used.
- The c-RNTI field in the MAC header is used to distinguish between UEs.
- In the uplink, the possibility of transport format selection exists.
- Selection of Access Service Classes (ASC) for RACH, details on definition of ASC and the relation to the RACH retransmission algorithm are ffs.
- Multiplexing/scheduling /priority handling is used to transmit the received information on RACH and CPCH.
- Channel selection is used to select an appropriately sized and available CPCH for transmission.
- Demultiplexing of received information inside MAC-c to CTCH is used to support Short Message Service Cell Broadcast (SMS CB).

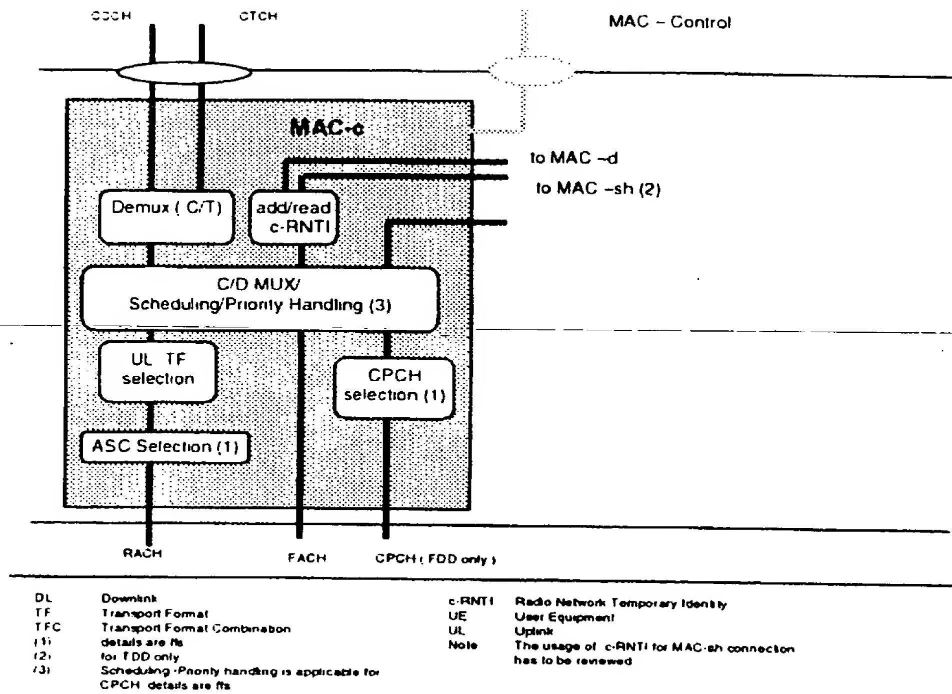
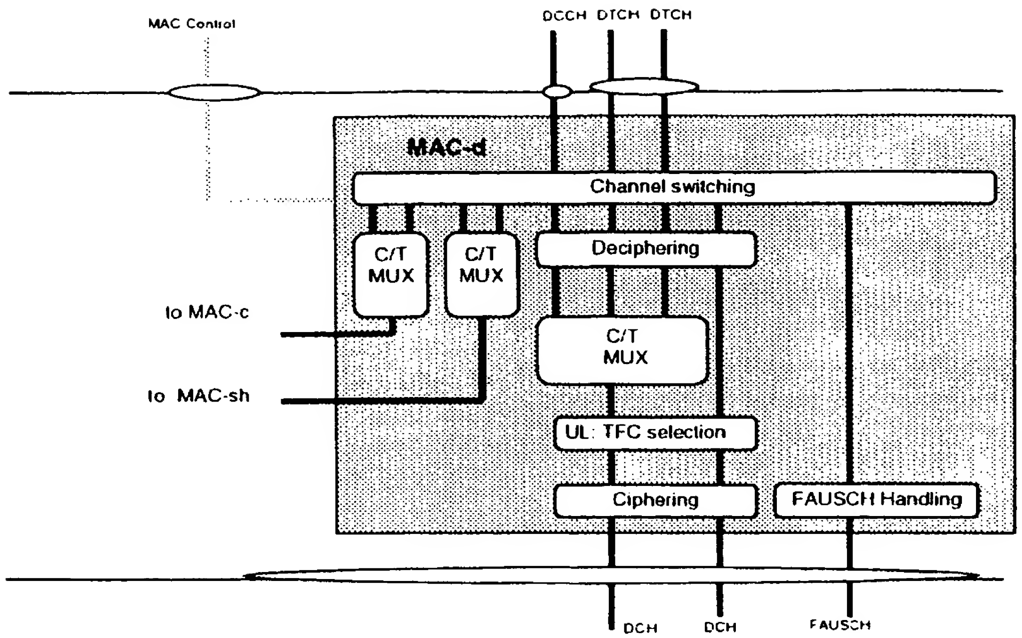


Figure 4.2.3.2. UE side MAC architecture / MAC-c details

Figure 4.2.3.3 shows the UE side MAC-d entity. The following functionality is covered:

- Dynamic transport channel type switching is performed by this entity, based on decision taken by RRC.
- The C/T MUX box is used when multiplexing of several dedicated logical channels onto one transport channel is used.
- The MAC-d entity using common channels is connected to a MAC-c entity that handles the scheduling of the common channels to which the UE is assigned.
- The MAC-d entity using downlink shared channel is connected to a MAC-sh entity that handles the reception of data received on the shared channels to which the UE is assigned.
- In the uplink, transport format combination selection (out of the RRC assigned transport format combination set) is performed to prioritise transport channels.
- FAUSCH Handling indicates the function in the MAC-d supports the FAUSCH, details are ffs
- Support of Ciphering / Deciphering for transparent RLC operation in MAC , see [2] for details on the concept.



DL	Downlink	RNTI	Radio Network Temporary Identity
TF	Transport Format	UE	User Equipment
TFC	Transport Format Combination	UL	Uplink
Note1	For DCH and DSCH different scheduling mechanism apply	Note 2	The TFC selection place is under discussion
		Note 3	Ciphering is performed in MAC-d only for transparent RLC mode

Figure 4.2.3.3. UE side MAC architecture / MAC-d details

Figure 4.2.3.4 shows the UE side MAC-sh entity. The following functionality is covered:

- RNTI is used on the DSCH Control Channel to identify the UE. Additionally, some timing / physical information is needed to tell the UE when to listen to DSCH.
- Multiplexing is used to transmit the received information on DSCH and DSCH Control Channel to the Mac-d, for TDD the multiplexing is used to transfer data from MAC-d to USCH and receives control information for shared operation from MAC-c.

The RLC has to provide RLC-PDU's to the MAC which fits into the available transport blocks on the transport channels respectively.

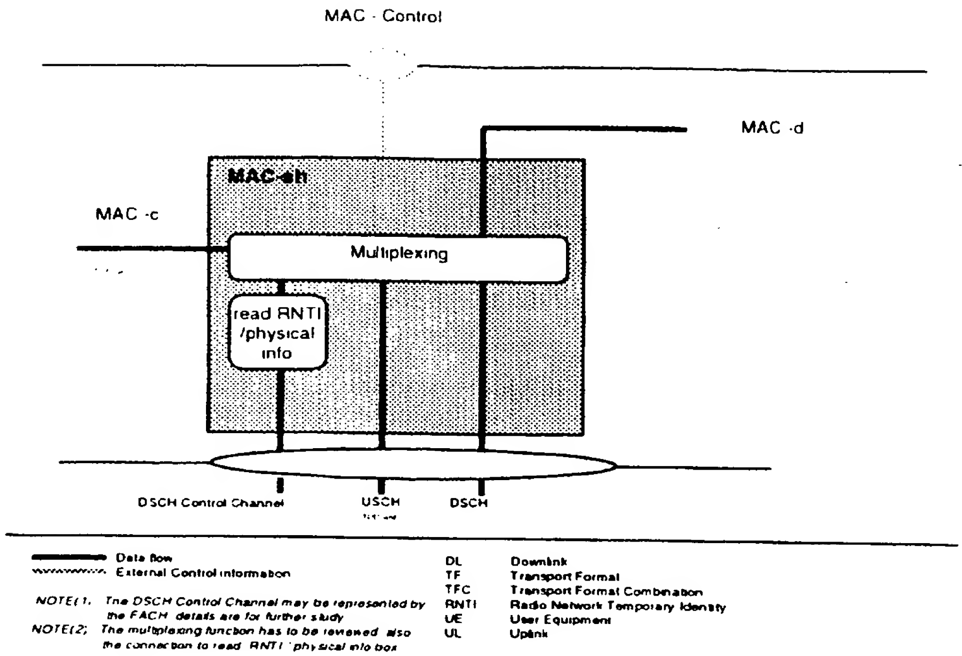


Figure 4.2.3.4. UE side MAC architecture / MAC-sh details

4.2.4. Traffic Related Architecture - UTRAN Side

Figure 4.2.4.1 illustrates the connectivity between the MAC entities from the UTRAN side. It is similar to the UE case with the exception that there will be one MAC-d for each UE and each UE (MAC-d) that is associated with a particular cell may be associated with that cells MAC-sh. MAC-c receives the CPCH transport blocks. MAC-c and Mac-sh are located in the controlling RNC while MAC-d is located in the serving RNC. The MAC Control SAP is used to transfer Control information to each MAC entity belongs to one UE.

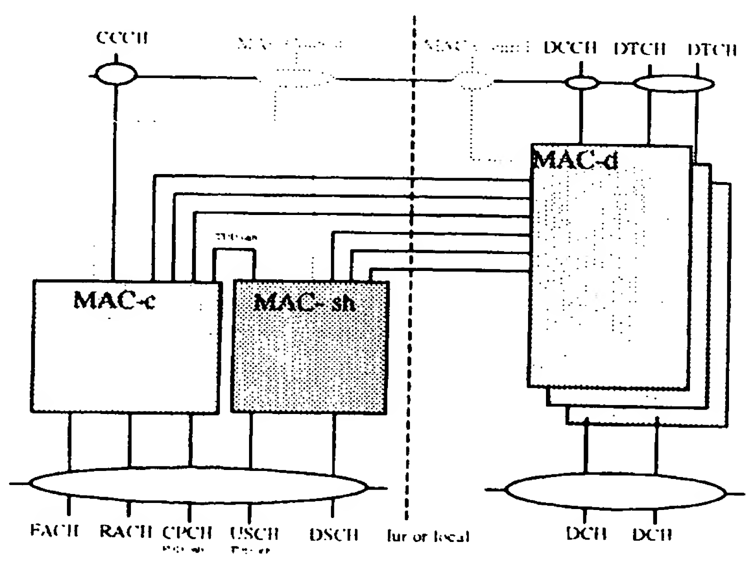


Figure 4.2.4.1: UTRAN side MAC architecture

Figure 4.2.4.2 shows the UTRAN side MAC-c entity. The following functionality is covered:

- The Scheduling – Priority Handling box manages FACH resources between the UE's and between data flows according to their priority. DL flow control is also provided to MAC-d.
- The C/D box represents the insertion and detection of the field in the MAC header, indicating whether a common or dedicated logical channel is used.
- For dedicated type logical channels, the c-RNTI field in the MAC header is used to distinguish between UEs.
- In the downlink, transport format selection might be done if FACH is variable rate.
- The multiplexing of CTCH information and the CB-Scheduling function inside MAC-c supports the Short Message Service Cell Broadcast (SMS CB).

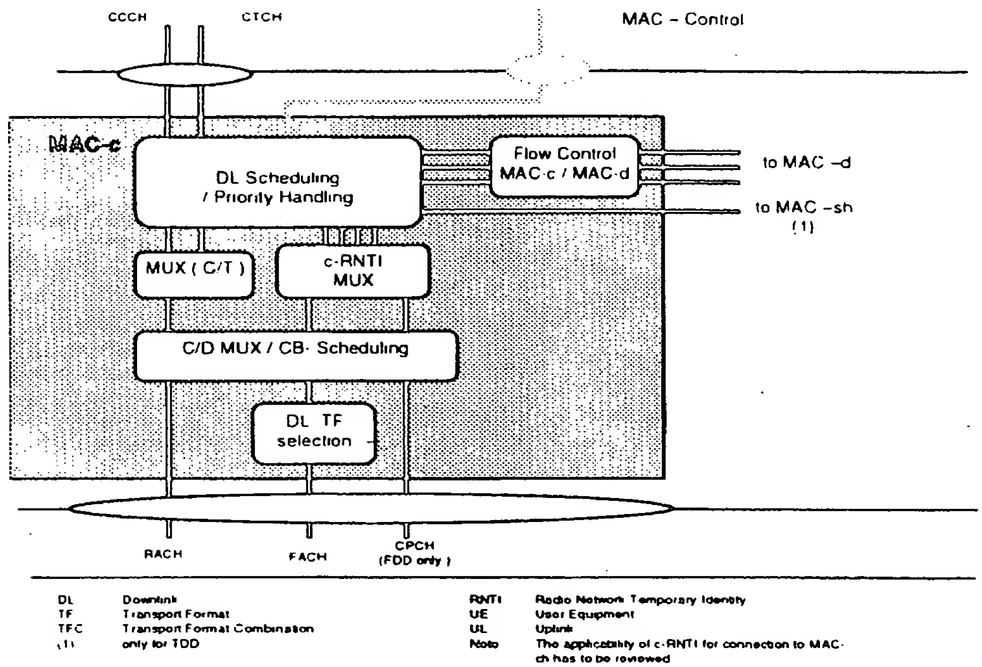


Figure 4.2.4.2 UTRAN side MAC architecture / MAC-c details

Figure 4.2.4.3 shows the UTRAN side MAC-d entity. The following functionality is covered:

- Dynamic transport channel type switching is performed by this entity, based on decision taken by RRC.
- The C/T MUX box is used when multiplexing of several dedicated logical channels onto one transport channel is used. C/T Mux is also responsible for priority setting on data received from DCCH / DTCH.
- Each MAC-d entity using common channels is connected to a MAC-c entity that handles the scheduling of the common channels to which the UE is assigned and DL (FACH) priority identification to MAC-c (priority identification of each PDU for DTCH NRT data is FFS).
- Each MAC-d entity using downlink shared channel is connected to a MAC-sh entity that handles the shared channels to which the UE is assigned and indicates the level of priority of each PDU to MAC-sh and to MAC-c.
- In the downlink, scheduling and priority handling of transport channels is performed within the allowed transport format combinations of the TFCS assigned by the RRC. This function supports the TFCI insertion in Node B .
- FAUSCH Handling indicates the function in the MAC-d supports the FAUSCH, details are ffs.
- Support of Ciphering / Deciphering for transparent RLC operation in MAC , see [2] for details on the concept.
- A flow control function exists toward MAC-c and MAC-sh to limit buffering between MAC-d and MAC-c or MAC-sh entities. This function is intended to limit layer 2 signalling latency and reduce discarded and

retransmitted data as a result of FACH or DSCH congestion. It also allows to handle quality of service if MAC-d requires it.

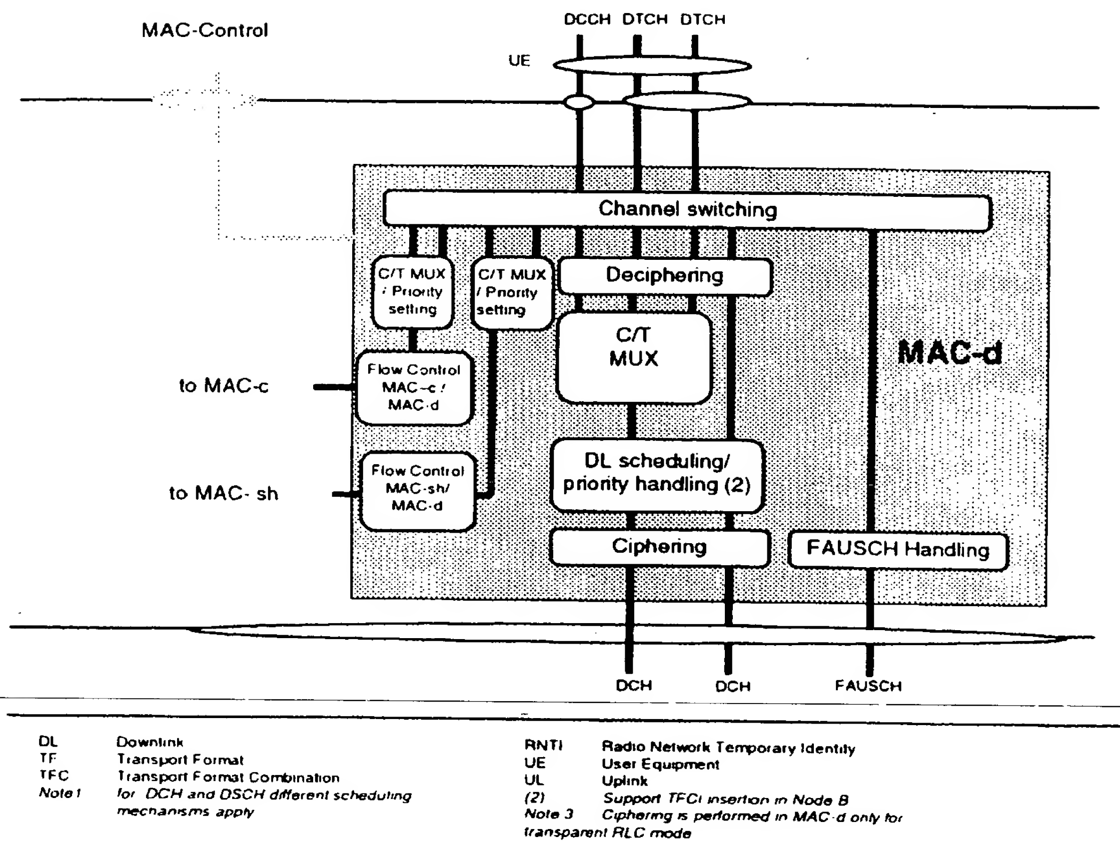


Figure 4.2.4.3 UTRAN side MAC architecture / MAC-d details

Figure 4.2.4.4 shows the UTRAN side MAC-sh entity. The following functionality is covered:

- A specific UE ID is needed when using the DSCH Control Channel to identify the UE on the DSCH. This specific UE ID may be optimised for DSCH and will be allocated when a RAB is mapped onto a DSCH. Additionally, some timing information is needed to tell the UE when to listen to DSCH.
- The scheduling /priority handling box in MAC-sh shares the DSCH resources between the UEs and between data flows according to their priority. For TDD operation the demultiplex function is used to support the USCH and the connection to the MAC-c.
- The scheduling/priority handling box also prioritizes between UL & DL capacity allocation indications when the FACH is used for both DSCH and USCH control channels (FACH is used for TDD - FDD is FFS).
- DL code allocation is used to indicate the code used on the DSCH and the appropriate Transport format on the DSCH.
- Flow control is provided to MAC-d.

(Note: Capacity allocation synchronization related to the USCH/ DSCH transmission is ffs.)

The RLC has to provide RLC-PDU's to the MAC which fits into the available transport blocks on the transport channels respectively.

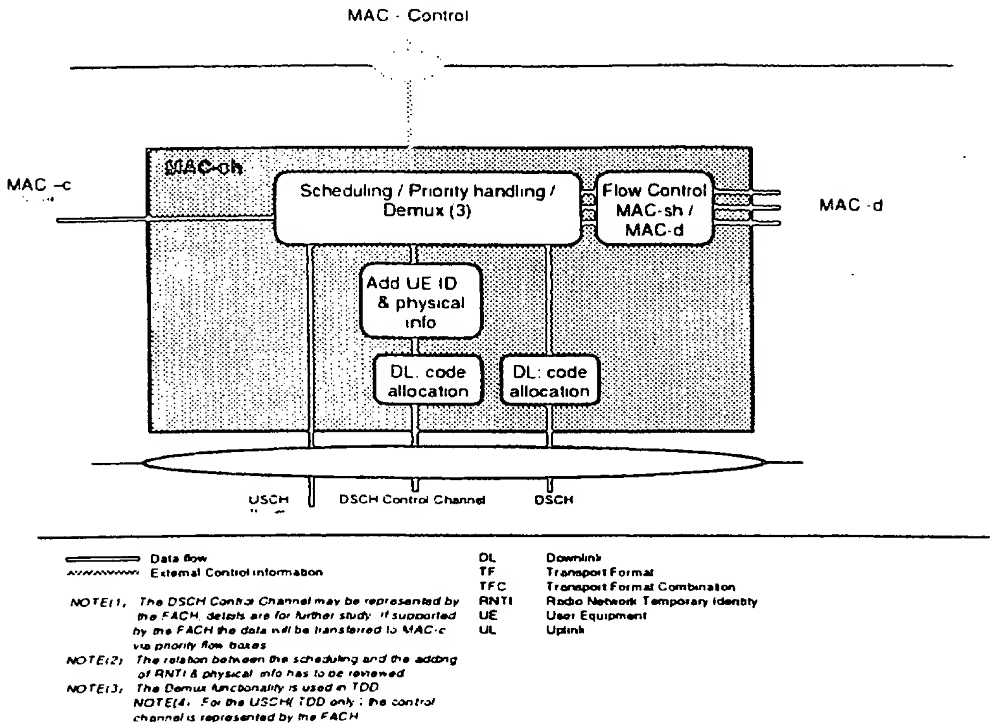


Figure 4.2.4.4 UTRAN side MAC architecture / MAC-sh details

4.3 Channel structure

The MAC operates on the channels defined below; the transport channels are described between MAC and Layer1, the logical channels are described between MAC and RLC. The following sections provide an overview, the normative description can be found in [2] and [3] respectively.

4.3.1 Transport channels

Common transport channel types are:

- Random Access Channel(s) (RACH)
- Forward Access Channel(s) (FACH)
- Downlink Shared Channel(s) (DSCH)
- DSCH Control Channel
- Common Packet Channel(s) (CPCH) for UL FDD operation only
- Uplink Shared Channel(s) (USCH), for TDD operation only
- ODMA Random Access Channel(s) (ORACH)
- Broadcast Channel (BCH)
- Synchronisation Channel (SCH), for TDD operation only
- Paging Channel (PCH)

Dedicated transport channel types are:

- Dedicated Channel (DCH)
- Fast Uplink Signalling Channel (FAUSCH)
- ODMA Dedicated Channel (ODCH)

4.3.2 Logical Channels

The MAC layer provides data transfer services on logical channels. A set of logical channel types is defined for different kinds of data transfer services as offered by MAC. Each logical channel type is defined by what type of information is transferred.

4.3.2.1 Logical channel structure

The configuration of logical channel types is depicted in Figure 4.3.2.1:

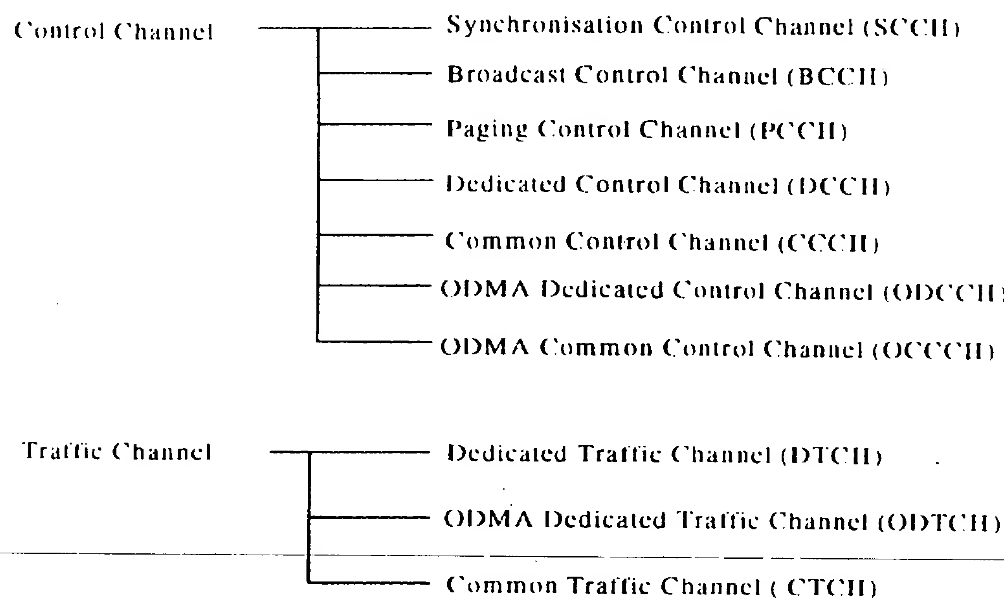


Figure 4.3.2.1 : Logical channel structure

4.3.2.2 Control Channels

Following control channels are used for transfer of control plane information only:

- Synchronisation Control Channel (SCCH)
- Broadcast Control Channel (BCCH)
- Paging Control Channel (PCCH)
- Common Control Channel (CCCH)
- Dedicated Control Channel (DCCH)
- ODMA Common Control Channel (OCCCH)
- ODMA Dedicated Control Channel (ODCCH)

4.3.2.3 Traffic Channels

Following traffic channels are used for the transfer of user plane information only:

- Dedicated Traffic Channel (DTCH)
- ODMA Dedicated Traffic Channel (ODTCH)
- Common Traffic Channel (CTCH)

4.3.3 Mapping between logical channels and transport channels

The following connections between logical channels and transport channels exist:

- SCCH is connected to SCH
- BCCH is connected to BCH
- PCCH is connected to PCH
- CCCH is connected to RACH and FACH
- DCCH and DTCH can be connected to either RACH and FACH, to CPCH and FACH, to RACH and DSCH, to DCH and DSCH, or to a DCH, the DCCH can be connected to FAUSCH.
- ODCCH, OCCCH and ODTCH can be connected to ORACH, ODCCH and ODTCH can be connected to ODCH.
- CTCH may be mapped to FACH and DSCH or BCH, the mapping is ffs
- DCCH and DTCH can be mapped to the USCH (TDD only).

5. Services provided to upper layers

5.1 Description of Services provided to upper layers

Data transfer

- Reallocation of radio resources and MAC parameters
- Reporting of measurements

The following potential service is regarded as a further study item:

- Allocation/de-allocation of radio resources

6. Functions

6.1 Description of the MAC functions

The functions of MAC include:

- Mapping between logical channels and transport channels.
- Selection of appropriate Transport Format for each Transport Channel depending on instantaneous source rate
- Priority handling between data flows of one UE
- Priority handling between UEs by means of dynamic scheduling
- Priority handling between data flows of several users on the the DSCH and FACH
- Scheduling of broadcast, paging and notification messages
- Identification of UEs on common transport channels
- Multiplexing/demultiplexing of higher layer PDUs into/from transport blocks delivered to/from the physical layer on common transport channels
- Multiplexing/demultiplexing of higher layer PDUs into/from transport block sets delivered to/from the physical layer on dedicated transport channels
- Traffic volume monitoring
- Monitoring the links of the assigned resources
- Routing of higher layer signalling
- Maintenance of a MAC signalling connection between peer MAC entities
- Dynamic Transport Channel type switching
- Ciphering for transparent RLC

The following potential functions is regarded as further study items:

- Processing of messages received at common control channels
- Successive Transmission on RACH

- Access Service Class selection for RACH transmission.

6.2 Relation between MAC Functions / Transport Channels and UE

6.2.1 Relation between MAC Functions and Transport Channels

Associated MAC Functions	Logical Ch	Transport Ch	TF Selection	Priority handling between users	Priority handling (one user)	Scheduling	Identification of UEs	Mux/Demux on common transport CH	Mux/Demux on dedicated transport CH	Dynamic transport CH switching
Uplink (Rx)	CCCH	RACH						X		
	DCCH	RACH					X	X		
	DCCH	CPCH					X	X		X
	DCCH	DCH							X	
	DTCH	RACH					X	X		
	DTCH	CPCH					X	X		X
	DTCH	DCH							X	
Downlink (Tx)	SCCH	SCH								
	BCCH	BCH				X				
	PCCH	PCH				X				
	CCCH	FACH		X				X		
	DCCH	FACH		X			X	X		
	DCCH	DSCH		X				X		
	DCCH	DCH	X		X				X	
	DTCH	FACH	X(note1)	X			X	X		X
	DTCH	DSCH	X(note2)	X				X		X
	DTCH	DCH	X		X				X	X

Table 1 UTRAN MAC functions corresponding to the transport channel (note3)

(Note1) On FACH channel, the transport format set is limited.
(Note2) Whether DSCH has the transport format set is under discussion.
(Note 3) The functions not included in the table are listed below.

- Mapping between logical channels and transport channels.
- Traffic volume monitoring
- Constrained execution of open loop power control algorithms

Further, the following additional functions are not included yet in the table :

- Routing of higher layer signalling
- Maintenance of a MAC signalling connection between peer MAC entities
- Monitoring the links of the assigned resources
- Processing of messages received at common control channels

Note (this table has to be reviewed)

6.2.2 Relation of UE MAC functions corresponding to the Transport Channel MAC Functions and Transport Channels

Functions	Logical Ch	Transport Ch	TF Selection	Priority handling data of one user	Identification	Mux/Demux on common transport channels	Mux/Demux on dedicated transport channels	Dynamic transport channel type switching
Uplink (Tx)	CCCH	RACH				X		
	DCCH	RACH	X(note1)		X	X		
	DCCH	CPCH	X	X	X	X		X
	DCCH	DCH	X	X			X	
	DTCH	RACH	X(note1)		X	X		X
	DTCH	CPCH	X	X	X	X		X
	DTCH	DCH	X	X			X	X
Downlink (Rx)	SCCH	SCH						
	BCCH	BCH						
	PCCH	PCH						
	CCCH	FACH				X		
	DCCH	FACH			X	X		
	DCCH	DSCH				X		
	DCCH	DCH					X	
	DTCH	FACH			X	X		
	DTCH	DSCH				X		
	DTCH	DCH					X	

Table 2 UE MAC functions corresponding to the transport channel

(Note1) The RACH channel has the limited transport format set.

Note: This table has to be reviewed

7. Services expected from physical layer

see TS25.302

8. Elements for layer-to-layer communication

8.1 Primitives between layers 1 and 2

see TS25.302

8.2 Primitives between MAC and RLC

8.2.1 Primitives

The primitives between MAC layer and RLC layer are shown in Table 8.2.1.1

Generic Name	Type				Parameters
	Request	Indication	Response	Confirm	
MAC-DATA	X	X			MU
MAC-ERROR		X			[FFS]
MAC-STATUS		X	X		[FFS]

Table 8.2.1 Primitives between MAC layer and RLC layer

MAC-DATA Request/Indication

- MAC-DATA Request primitive is used to request that an upper layer PDU be sent using the procedures for the information transfer service.
- MAC-DATA Indication primitive indicates the arrival of an upper layer PDU received by means of the information transfer service.

MAC-ERROR Indication

- MAC-ERROR Indication primitive indicates to RLC that an error condition has occurred.

MAC-STATUS Indication/Response

- MAC-STATUS Indication primitive indicates to RLC about changes in the rules under which it may transfer data to MAC. Parameters of the primitive can indicate a transmission timer value, whether the RLC can transfer data and whether that data is restricted to supervisory frames only.
- MAC-STATUS Response enables RLC to acknowledge a MAC-STATUS Indication. It is possible that RLC would use this primitive to indicate that it has nothing to send or that it is in a suspended state.

8.2.2 Parameters

a) Message Unit (MU)
It contains the RLC layer message (RLC-PDU) to be transmitted or received by the MAC sub-layer.

[Note (from Tdoc WG2 009/99): This description are based on L2-LAC specification drafted TTC/ARIB Joint meeting. Because SAP between LAC and MAC is defined in our structure of MAC, the name of Signal is changed to Primitive. And format of explanation of primitives are changed to avoid verbose description. Request and Indication are combined to explain. Primitives for Activation/Deactivation or Establish/Release or Connect/Disconnect for MAC connection are FFS.]

[Note (from Tdoc WG2 009/99): The parameters for RLCMAC-ERROR and RLCMAC-STATUS are FFS.]

8.3 Primitives between MAC and RRC

8.3.1 Primitives

The primitives between MAC and RRC are shown in Table 8.3.1

Generic Name	Type				Parameters
	Request	Indication	Response	Confirm	
CMAC-CONFIG	X				CHI
CMAC-CONNECT	X			X	IIs
CMAC-MEASUREMENT	X	X			TRIG TH, RESULT, PER
CMAC-STATUS		X			Status info.
CMAC-ERROR		X			Reason for error

Table 8.3.1 Primitives between MAC sub-layer and RRC

CMAC-CONFIG Request

- CMAC-CONFIG Request is used to request for the switching the connection between logical channels and transport channels

CMAC-CONNECT Request/Confirm

- CMAC-CONNECT Request is used initiate a RRC connection
- CMAC-CONNECT Confirm is used to confirm the establishment of a RRC connection.

CMAC-MEASUREMENT Request/Indication

- CMAC-MEASUREMENT .Request is used to request to measure something radio quality at both BS and MS sides. (for example : Transport Block Error)
- CMAC-MEASUREMENT. Indication is used to notify measuring result.

CMAC-STATUS Indication

- CMAC-STATUS Indication primitive notifies the management entity of status information.

CMAC-ERROR Indication

- CMAC-ERROR Indication primitive notifies the management entity of an error detected in the operation of the MAC sub layer protocol such as excessive number of transmission attempts for Ack-mode. and timer time out.

8.3.2 Parameters

a) Channel Information (CHI)
Channel information for active transport channel. For example, common channel or dedicated channel notification in user packet transmission.

b) TH
Threshold information for measurement. For example, traffic monitor or transmission quality. When an specific value is assigned, it means measuring should be reported with law data.

c) PER

Period information for measurement. When an specific value is assigned, it means measuring should be reported only when measuring result exceed the given threshold.

d) TRIG
Trigger information which request to start measuring.

e) RESULT
Measurement result.

f) Status info
It is management entity of status information.

g) Reason for error
It contains the management entity of an error detected in the operation of the MAC sub layer protocol (e.g. excessive number of transmission attempts for Ack-mode).

[Note(from Tdoc WG2 009/99): If used with a threshold information, the MEASURE primitive is same as an alarm indication or request for channel switching. When the condition that channel switching is needed is detected at UE side, appropriate RRC message will be sent to Network side.

9. Elements for peer-to-peer communication

9.1 Protocol data units

9.1.1 MAC Data PDU

MAC PDU consists of an optional MAC header and a MAC Service Data Unit (MAC SDU), see figure 9.1.1. Both the MAC header and the MAC SDU are of variable size.

The content and the size of the MAC header depends on the type of the logical channel, and in some cases none of the parameters in the MAC header are needed.

The size of the MAC-SDU depends on the size of the RLC-PDU, which is defined during the setup procedure.

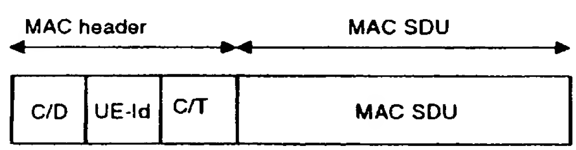


Figure 9.1.1.1 MAC data PDU

9.1.2 MAC Control PDU

MAC Control PDU consist elements for the control of the operation. The details are ffs.

9.2 Formats and parameters

9.2.1 MAC Data PDU: Parameters of the MAC header

The following fields are defined for the MAC header:

- C/D field
  The C/D field is a single-bit flag that provides identification of the logical channel class on FACH and RACH transport channels, i.e. whether it carries CCCH or dedicated logical channel information.

C/D field	Designation
1	CCCH
0	DCCH or DTCH

Table 9.2.1.1: Coding of the C/D Field

- C/T field
  The C/T field provides identification of the logical channel instance when multiple logical channels are carried on the same transport channel. The C/T field is used also to provide identification of the logical channel type on dedicated transport channels and on FACH and RACH when used for user data transmission. The size of the C/T field may be variable.

C/T field (e.g. 4 bits)	Designation
0000	Logical channel 1
0001	Logical channel 2
...	...
1111	Logical channel 16

Table 9.2.1.2: Structure of the C/T field

- UE-Id
  The UE-Id field provides an identifier of the UE . The following types of UE-Id are currently defined:

s-RNTI , this UE Id is related to the serving RNC
c-RNTI, this UE Id is related to the controlling RNC.

In addition for UE's having a RRC connection the S-RNC identifier exist.

s-RNTI together with S-RNC identifier is used for URA update RRC connection reestablishment and UTRAN originated paging messages and there associated responses.

c-RNTI is used as a UE identifier in all other DCCH/DTCH common channel messages on the air interface.

Note: Whether or not other UE-Id types are needed is ffs.

9.2.1.1 MAC header for DTCH and DCCH

a) DTCH or DCCH mapped to DCH, no multiplexing of dedicated channels on MAC:
   No MAC header is required.

b) DTCH or DCCH mapped to DCH, with multiplexing of dedicated channels on MAC:
   C/T field is included in MAC header.

c) DTCH or DCCH mapped to RACH/FACH:
   C/D field and UE-Id are included in the MAC header. C/T field is included if multiplexing on MAC is applied.

d) DTCH or DCCH mapped to RACH/FACH, where DTCH or DCCH are the only channels (ffs).
   UE-Id field is included in MAC header. C/T field is included if multiplexing on MAC is applied.

e) DTCH or DCCH mapped to DSCH:
   The MAC-PDU format for DSCH is left for further study.

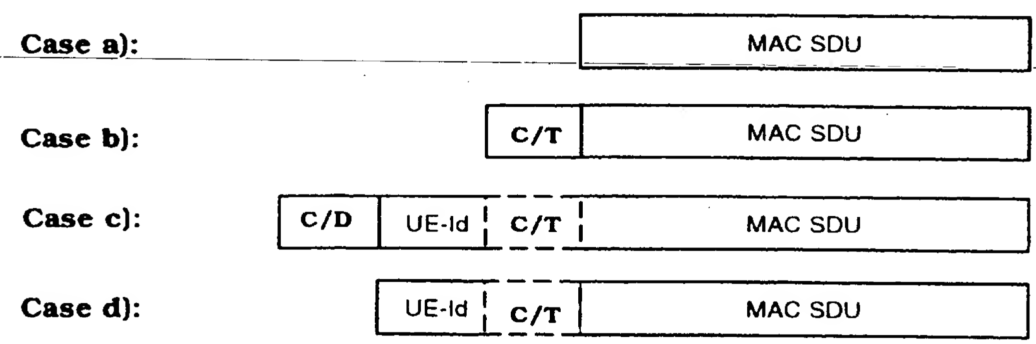


Figure 9.2.2.1: MAC Data PDU formats for DTCH and DCCH

9.2.1.2 MAC header for CCCH

Note: The concept for using UE Id on CCCH has to be reviewed

a) CCCH mapped to RACH/FACH:
   C/D has to be included and UE-id field may be included in MAC header. Details of usage the UE-id field is ffs.
b) CCCH mapped to RACH/FACH, where CCCH is the only channel (ffs):
   UE-id field may be included in the MAC header.

Note: The usage of the MAC header for BCCH and PCCH is ffs.
The address used for initial addressing is ffs, a possible solution may be to use a Random or CN related Identifier.

Case a):

C/D	UE-Id	MAC SDU

Case b):

UE-Id	MAC SDU

Figure 9.2.1.2.1 : MAC Data PDU formats for CCCH

9.2.1.3 MAC Header for CTCH

The MAC header for CTCH mapped to FACH is as shown in figure 9.2.1.3.1

C/D	C/T	MAC SDU

Figure 9.2.1.3.1 : MAC Data PDU format for CTCH

C/D field indicates whether data is mapped to the common or dedicated logical channel.

C/T field indicates whether it belongs to CCCH or CTCH. In case of CTCH, it identifies whether the message is SMS CB message or Schedule message

9.2.2 Control PDUs

MAC Control PDU elements have to be described, the details are ffs.

9.3 Protocol states

(Description of states, provision of state transition diagram(s))

9.4 State variables

9.5 Timers

9.6 Protocol Parameters

(e.g. max, min values of state variables to be initialised)

9.7 Specific functions

(description of specific protocol functions, if applicable)

10. Handling of unknown, unforeseen and erroneous protocol data

11. Elementary procedures

Examples: data transfer, random access procedure, transport channel type switching (dedicated/common channel)

11.1 Dynamic radio bearer control in UE

- This procedure is applicable only in case of optimisation of established radio bearers
- The algorithm exist in the UE and is controlled by the network. The algorithm requests to RRC for a reconfiguring of radio resources, details are ffs.

11.2 Control of RACH transmissions

[Note: This procedure has to be reviewed for FDD and TDD operation]

The MAC sublayer is in charge of controlling the timing of RACH transmissions on transmission time interval level (i.e. on 10 ms-radio frame level; the timing on access slot level is controlled by L1). MAC controls the timing of each initial preamble ramping cycle as well as successive preamble ramping cycles in case that none or a negative acknowledgement is received. Note that retransmissions in case of erroneously received RACH message part are under control of higher layers (i.e. RLC, or RRC for CCCH data).

The RACH transmissions are performed by the UE as shown in Figure 2. MAC receives the following RACH transmission control parameters from RRC with the CMAC-Config-REQ primitive:

- persistence value P (transmission probability),
- maximum number of preamble ramping cycles M_{max}.
- others (ffs., e.g. minimum and maximum number of time units between two preamble ramping cycles).

Based on the persistence value P, the UE decides whether to start the L1 power ramping procedure in the present transmission time interval or not. If transmission is allowed, the L1 preamble power ramping procedure is started. MAC then waits for status indication from L1. If transmission is not allowed, a backoff timer T_{BO1} is started and another attempt is performed after expiry of the timer.

When the preamble has been acknowledged on AICH, the RACH message part is transmitted according to L1 specifications. When no acknowledgement is received, a backoff timer T_{BO2} is started and another preamble ramping cycle is performed. In case that a negative acknowledgement has been received on AICH a backoff timer T_{BO3} is started. After expiry of the timer persistence check is performed again.

The settings of the backoff timers T_{BO1}, T_{BO2}, T_{BO3} is ffs. The setting is an integer number (≥ 1) of transmission time intervals, either fixed or randomly drawn from an interval defined by RACH transmission control parameters received from RRC, which might be updated dynamically, together with update of persistence value.

[Note: The three timers are introduced at this stage mainly to keep the algorithm most general. Possibly T_{BO1} and T_{BO2} can simply be set to their minimum value, which is currently assumed to be 10 ms. However, smaller backoff timing units such as access slot intervals may also be considered. The introduction of random backoff with T_{BO1} could especially be useful when the update time for the persistence value is low, i.e. larger than a radio frame.]

The backoff algorithm encompasses currently both

(a) a persistency check and

(b) a backoff time

at both stages,

- initial (i.e. very first) attempt after the request to send RACH data has been received by MAC, and
- subsequent attempt, which is needed in case of the following conditions:
  - (i) after an unsuccessful preamble ramping cycle (No Ack)
  - (ii) after a Nack from L1.

For both stages it is FFS if both (a) and (b) are needed or if one of (a) or (b) is sufficient.

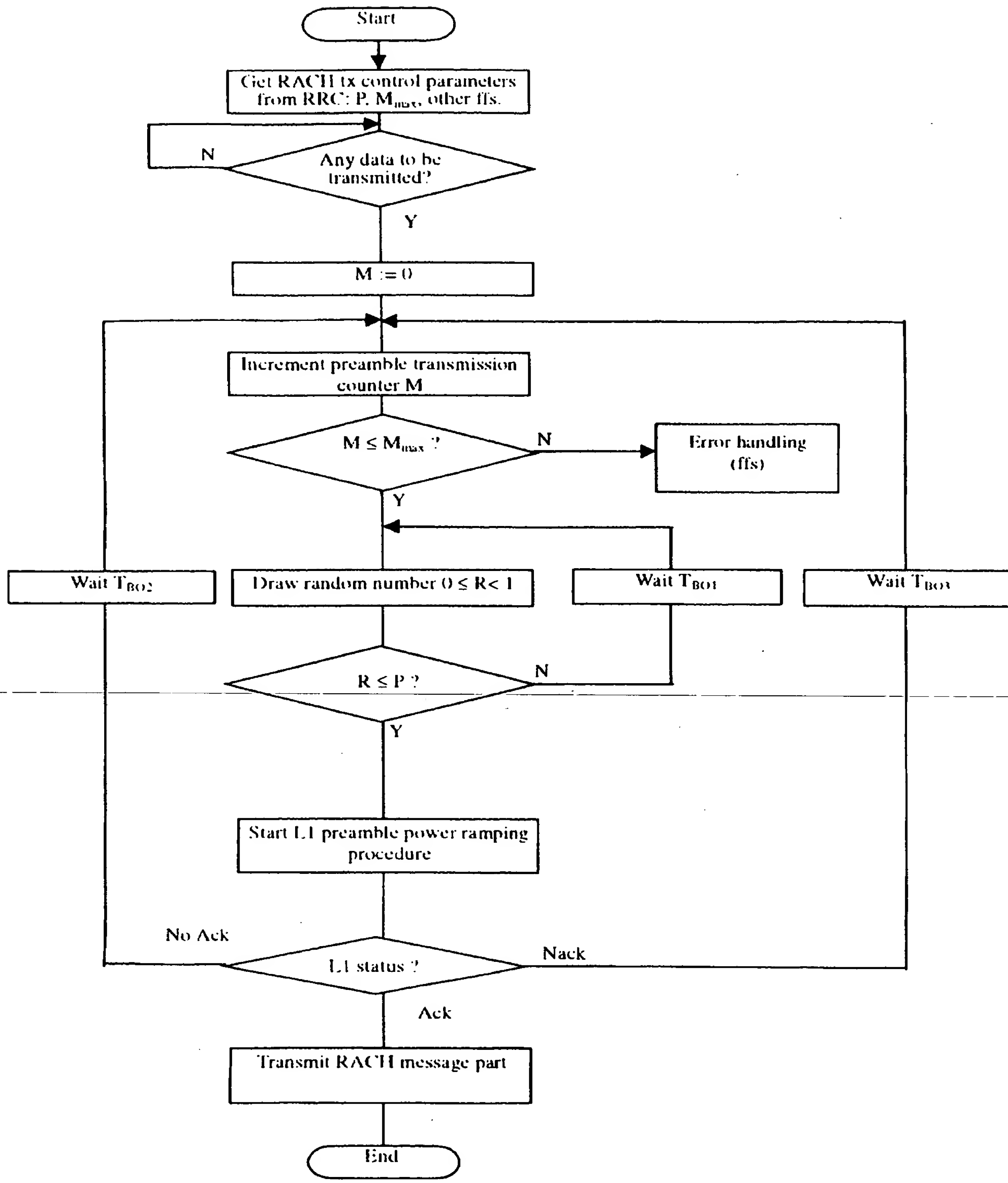


Figure 11.2.1 : RACH transmission control procedure (UE side, informative)

12. History

Document history		
Date	**Version**	**Comment**
January 1999	0.0.1	Document created. Based on TSG RAN WG2 Tdoc 015/99, 009/99 and 028/99.
March 1999	0.0.2	Document adapted to the new 3GPP layout, reflects email discussion on MAC–sh, descriptions for FAUSCH handling moved to MAC –d
April 1999	0.0.3	Changes after TSG RAN WG2#2: Service Access Classes . Scheduling function UTRAN side MAC-d and modified PDU format incorporated. MAC-RLC and MAC-RRC primitives renamed.
April 1999	0.1.0	Changes after TSG RAN WG2#3: List of Channels. MAC functions updated. Update for UE Id usage. Incorporation of USCH. MAC-sh updated. Changes to support MAC per to peer communication. Retransmission removed from MAC-c. MAC PDU updated. Document for approval by TSG RAN.
April 1999	TS 25.321 V2.0.0	Endorsed by TSG-RAN as TS 25.321 V2.0.0
May 1999	TS 25.321 V2.0.1	References updated after TSG RAN #3
June 1999	TS 25.321 V2.1.0	Changes after TSG RAN WG2#4: Introduction of the CPCH concept. MAC-c changes covering CTCH. Introduction of MAC flow control, priority handling on FACH. Changes reflects the RLC-MAC ciphering concept. Annexes restructured. Document for approval by TSG RAN#4.
June 1999	TS 25.321 V3.0.0	Approved by TSG-RAN

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Annex A (informative):

Description of random access procedure

[Note: This annex has to be reviewed for FDD and TDD operation]

A.1 Assumptions

The following assumptions for RACH transmission are made (for completeness assumptions are made also for other layers than MAC):

UE side:

- PRACH transmissions are triggered by data request from MAC to PHY (PHY-Data-REQ). This implies that any desired backoff in PRACH transmissions is controlled by MAC (or higher layer).
- The physical layer uses the PHY-Status-IND primitive to indicate the following conditions to MAC:
  - ~~Maximum preamble transmit power reached, no acknowledgement on AICH received.~~
  - Negative acknowledgement received on AICH ("Nack") indicating that the preamble has been acquired, but transmission of the message shall be suspended.
  - Positive acknowledgement received on AICH ("Ack"), RACH message has been transmitted.
- The following PRACH parameters are configured by RRC through C-SAP by means of CPHY-TrCH-Config-REQ primitive:
  - initial transmit power,
  - power ramping step size,
  - preamble-to-message transmit power offset,
  - PRACH maximum power
  - PRACH spreading code,
  - Access Service Class (ASC) parameters (ffs.).
- Configuration of AICH parameters by RRC (using CPHY-TrCH-Config primitive)
  - AICH spreading code
  - timing information for search of acquisition indicator (if needed)
- The following parameters are randomly selected by the physical layer (possibly within constraints defined by ASC parameters):
  - PRACH initial access slot,
  - PRACH signature

UTRAN side:

- Continuous monitoring of the PRACH is handled by layer 1 procedures. There is only a single primitive needed between PHY and MAC, indication of data (PHY-Data-IND).

A.2 Example message sequence for random access procedure

RACH transmissions are split into two phases, preamble power ramping and message transmission. The message is transmitted when acquisition of the preamble has been acknowledged, where a fixed timing between that last transmitted preamble, the acquisition indicator and the message needs to be maintained. Under certain conditions (see below) it will be necessary to perform multiple attempts of preamble power ramping before the message can be sent.

The timing of RACH transmissions on transmission time interval level is controlled by the MAC sublayer (i.e. introduction of backoff delay based on transmission time interval units).

An example message sequence for random access is shown in Figure 1. RACH transmission is performed as follows:

The RACH and AICH are configured once via a CPHY-TrCH-Config-REQ primitive. This primitive needs to be issued only for initial configuration or when a parameter shall be changed, not for every RACH transmission.

The CMAC-Config-REQ primitive is used to configure MAC parameters required for the random access procedure. The parameters could include random access control parameters such as, e.g. persistence value, maximum number of preamble ramping cycles, and minimum and maximum backoff time in terms of number of transmission time intervals (i.e. radio frames of 10 ms) when transmission is allowed.

[Note: Above listed access control parameters are only examples for further study. Also it is ffs how the access control parameters are obtained by RRC from e.g. broadcast information.]

When there is data to be transmitted on the RACH, i.e. reception of a MAC-Data-REQ primitive, the RACH transmission control procedure is started.

After some initial backoff, a primitive PHY-Data-REQ is sent to L1, which triggers the PRACH preamble transmission procedure, i.e. the physical layer selects a PRACH access slot without further backoff delay imposed on L1 (possibly within ASC constraints). Note that the initial backoff time may in certain conditions be set to zero (e.g. when the uplink load is low).

In the example it is assumed that the preamble power ramping procedure is completed with one of the following conditions:

(i) maximum permitted transmission power was reached without receiving an acknowledgement, or

(ii) a negative acknowledgement (Nack) has been received on AICH.

The first condition can be due to following reasons:

1.) missed preamble in Node B at max power due to detection probability <1,

2.) collision with another user,

3.) an acknowledgement was sent but it was missed at the UE.

This condition should occur very rarely and may not necessarily require backoff for a repetition of the preamble ramping cycle (except case 1.) is due to overload, which however should be prevented by the system in some suitable way). However some backoff should be imposed to provide a better interference distribution over time.

The second condition, reception of "Nack" on AICH, shall be used to prevent the user from sending his message in case of danger of a temporary congestion (it could be ignored by "special users"). In this case, a new access attempt should be started by MAC after some further backoff delay. Note that this "subsequent" backoff time might be calculated differently than the *initial* backoff time applied in the first preamble power ramping cycle. Also, the subsequent backoff time may be set differently for either of the above conditions (i) and (ii).

This condition could occur a number of consecutive times. The number of preamble ramping cycles is counted on MAC. When the maximum number of cycles is exceeded an error condition is signaled to RRC (with CMAC-Status or CMAC-Error primitive, ffs.) and the MAC PDU is removed.

Upon successful transmission of a preamble, MAC receives an acknowledgement via PHY-Status-IND primitive that the acquisition indicator was received and the message sent.

At the UTRAN-side MAC the further processing of received RACH message depends on the MAC header. An acknowledgement that the message was received correctly is either be given by RRC procedure or by a RLC retransmission procedure, depending on the type of the message. The parameters of PRACH transmission are chosen such that retransmission of the messages is a very rare event. Incorrectly received messages should not be due to

overload situations since this condition should have been signaled via the Nack on AICH after preamble acquisition. It is thus not needed to impose an additional outer backoff time for retransmission of the message. Message retransmission shall be handled entirely on RLC, or RRC for CCCH messages, employing retransmission timers.

It should be noted that for transmission on common transport channels some parameters of the RLC retransmission protocol may need to be updated to cope with delays introduced by the MAC RACH transmission control function.

[Note: An additional negative acknowledgement (Nack) given by L1 for erroneously received RACH message part is ffs.]

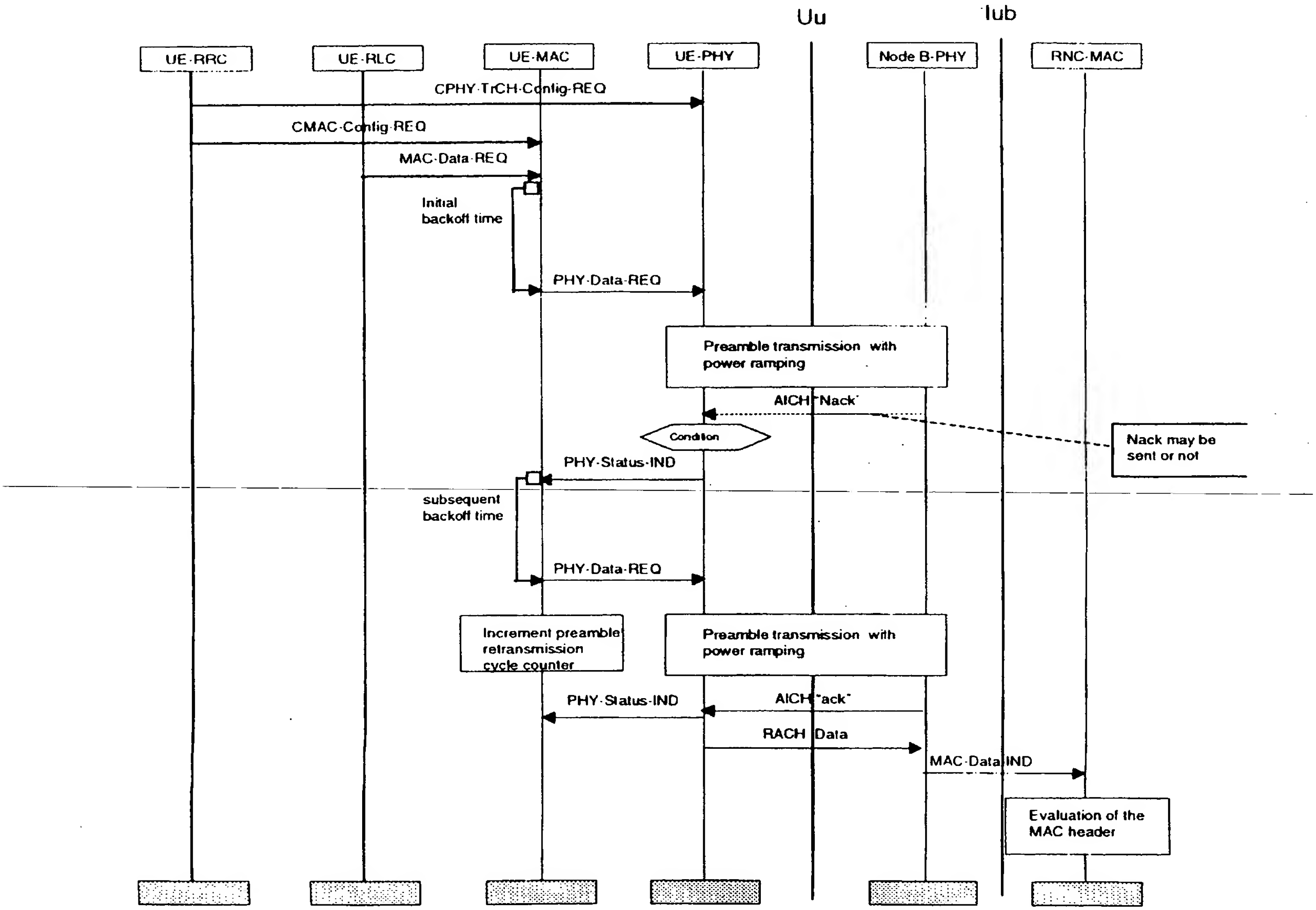

Figure A.1: Example random access transmission sequence

ANNEX B (informative):

Control of CPCH

B.1 Overview

The Common Packet Channel (CPCH) is multi-access contention based transport channel in the uplink .

The MAC may multiplex control and user data from multiple logical channels in the same CPCH transmission. The MAC functions associated with the CPCH are

- Scheduling
- Multiplexing/demultiplexing
- Inband identification of UEs

Procedures associated with the CPCH are

- CPCH access procedure (see Annex B in TS25.301[2])

B.2 Scheduling of control and user data transmission

Scheduling of control and data transmission on CPCH is similar to that of RACH (cf. 14.2.4.2).

Transmission scenarios for CPCH include:

- Initial CPCH transmission
- CPCH Busy Retransmission
- Collision Detected Retransmissio

B.3 Multiplexing/demultiplexing of higher layer PDUs to/from CPCH transport blocks

UE MAC supports service multiplexing for CPCH transport channels similar to the RACH (cf. 14.2.4.3).

B.4 Inband Identification of UEs

Inband identification of UEs for the CPCH is identical to that for the RACH (cf. 14.2.4.4)

B.5 Selection of CPCH Channel

UE MAC monitors the availability of the CPCH channels in the CPCH Set allocated to the UE. UE MAC selects an available channel considering RNC persistency parameter and the capacity of the CPCH. If access to the selected CPCH is denied, channel reselection and retransmission may occur.

ANNEX C (informative):

MAC peer to peer communication

C.1 MAC messages for MAC peer to peer communication

(Note: Based on Tdoc TSGRAN WG2 285/ 99 for the use of MAC peer to peer communication WG2 has agreed to incorporate MAC messages for peer to peer communication into TS25.321. details are for further study.)

C.2 Format of MAC messages for MAC peer to peer communication

(Note: Based on Tdoc TSGRAN WG2 285/ 99 for the use of MAC peer to peer communication WG2 has agreed to incorporate MAC messages for peer to peer communication into TS25.321. details are for further study.)